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IB3-0009

T00-0230

### Disclosure YOR8-1999-0831

Prepared for and/or by an IBM Attorney - IBM Confidential



Created By: Timothy Dalton Created On:  
Last Modified By: Linda Gray Last Modified On:

Required fields are marked with the asterisk (\*) and must be filled in to complete the form.

#### \*Title of disclosure (In English)

T00-0230 PECVD Low Dielectric Constant ILD With Improved Photolithography Properties

#### Summary

Status	Under Evaluation
Original Location	YOR
Processing Location	FIS
Functional Area	ZDDA ... for IPLaw Department Use Only
Attorney/Patent Professional	Steven Capella/Fishkill/IBM
IDT Team	Rama Divakaruni/Burlington/IBM
Submitted Date	
Owning Division	MD
Incentive Program	
Lab	
Technology Code	
PVT Score	59

#### Inventors with Lotus Notes IDs

Inventors: Timothy Dalton/Fishkill/IBM, Christopher Jahnes/Watson/IBM, Dan Edelstein/Watson/IBM, William Cote/Fishkill/IBM, Gill Lee/Fishkill/Contr/IBM

Inventor Name	Inventor Serial	Div/Dept	Inventor Phone	Manager Name
Dalton, Timothy J. -h	909412	29/GTIA	N/A	Surendra, Maheswaran
Jahnes, Christopher	071841	22/K9UH	N/A	Surendra, Maheswaran
Edelstein, Daniel C.	620780	22/OMOE	N/A	Narayan, C. (Spike)
Cote, William -h	090185	29/FKLA	N/A	Havas, Janos
Lee, Gill Yong *PARTNER*	4481+1	29/38YA	N/A	Chasloux, Susan E.

> denotes primary contact

#### Inventors without Lotus Notes IDs

#### IDT Selection

Select Functional Area

IDT Team: Rama Divakaruni/Burlington/IBM	Attorney/Patent Professional: Steven Capella/Fishkill/IBM
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**Response Due to IP&L :****\*Main Idea**

1. Describe your invention, stating the problem solved (if appropriate), and indicating the advantages of using the invention.

Currently, PECVD organosilicate low dielectric constant (low-k) films are deposited from a number of precursors such as methylsilane (1MS), trimethyl silane (3MS) and tetramethylsilane (4MS). The deposition process to form a low-k film uses these precursors in conjunction with an oxidizing agent (typically N<sub>2</sub>O). However, there is a problem with this approach. A film formed from these components contains a slight amount of amine components which can be detected with a FTIR as a 3300 cm<sup>-1</sup> N-H peak. It is known in the art that amines and related species can "poison" a deep ultraviolet (DUV) photolithography (litho) process by neutralizing and deactivating the photoacid generators (PAGs) that chemically amplify the light used to expose the photoresist. It is advantageous to use a different combination of precursors to form the low-k film. The silane precursors (1MS, 3MS, 4MS, with optional mixing of Silane to adjust film properties such as hardness) do not change. However, a new oxidizing agent is employed to prevent the formation of amines that poison the lithography process. The new oxidizers that can be used to form this low-k film include CO and CO<sub>2</sub>. A low-k film formed from a combination of a silane (1MS, 3MS, 4MS, and SiH<sub>4</sub>) and an oxidizer (CO, CO<sub>2</sub>) has the advantageous property of not poisoning the photolithography process, and thus allowing for the successful build of an integrated circuit device.

2. How does the invention solve the problem or achieve an advantage, (a description of "the invention", including figures inline as appropriate)?

The invention uses a new oxidizing agent to replace one that has recently been discovered to cause problems with other processing steps.

3. If the same advantage or problem has been identified by others (inside/outside IBM), how have those others solved it and does your solution differ and why is it better?

Others have also seen that there is a problem, but to date no one has achieved a solution to solve this problem.

4. If the invention is implemented in a product or prototype, include technical details, purpose, disclosure details to others and the date of that implementation.

This low-k film is an alternative to the SiLK organic dielectric currently being investigated for use in IBM's CMOS9S and CMOS8S2 generations of technology. If the Low-K film is effective, it may be backfilled into CMOS8S or CMOS8S2 to provide a mid-life boost in performance.

**\*Critical Questions (Questions 1-9 must be answered)****\*Question 1**

On what date was the invention workable?

Please format the date as MM/DD/YYYY

(Workable means i.e. when you know that your design will solve the problem)

**\*Question 2**

Is there any planned or actual publication or disclosure of your invention to anyone

☐ Yes  
☒ No

outside IBM?
If yes, Enter the name of each publication or patent and the date published below.
Publication/Patent:
Date Published or Issued:
Are you aware of any publications, products or patents that relate to this invention? <input type="radio"/> Yes <input checked="" type="radio"/> No
If yes, Enter the name of each publication or patent and the date published below.
Publication/Patent:
Date Published or Issued:

<b>*Question 3</b>	<input type="radio"/> Yes <input checked="" type="radio"/> No
Has the subject matter of the invention or a product incorporating the invention been sold, used internally in manufacturing, announced for sale, or included in a proposal?	
Is a sale, use in manufacturing, product announcement, or proposal planned?	<input checked="" type="radio"/> Yes <input type="radio"/> No
If Yes, identify the product if known and indicate the date or planned date of sale, announcements, or proposal and to whom the sale, announcement or proposal has been or will be made.	
Product: Alternate firm for CMOS9S/BS2	
Version/Release:	
Code Name:	
Date:	
To Whom:	
If more than one, use cut and paste and append as necessary in the field provided.	

<b>*Question 4</b>
Was the subject matter of your invention or a product incorporating your invention used in public, e.g., outside IBM or in the presence of non-IBMers?
If yes, give a date. Please format the date as MM/DD/YYYY <input type="radio"/> Yes <input checked="" type="radio"/> No

<b>*Question 5</b>	<input type="radio"/> Yes <input checked="" type="radio"/> No
Have you ever discussed your invention with others not employed at IBM?	
If yes, identify individuals and date discussed. Fill in the text area with the following information, the names of the individuals, the employer, date discussed, under CDA, and CDA #.	

<b>*Question 6</b>	<input type="radio"/> Yes <input checked="" type="radio"/> No <input type="radio"/> Not sure
Was the invention, in any way, started or developed under a government contract or project?	
If Yes, enter the contract number	

<b>*Question 7</b>	<input checked="" type="radio"/> Yes <input type="radio"/> No <input type="radio"/> Not Sure
Was the invention made in the course of any alliance, joint development or other contract activities?	
If Yes, enter the following (in English):	
Name of Alliance, Contractor or Joint Developer BDA	
Contract ID number	T00-0230
Relationship contact name	
Relationship contact E-mail	

Relationship contact phone

**\*Question 8**

Have you, or any of the other inventors, submitted this same invention disclosure or similar invention disclosure previously?

☐ Yes☒ No

If Yes, please provide disclosure number below:

**\*Question 9**

Are you, or any of the other inventors, aware of any related inventions disclosures submitted by anyone in IBM previously?

☐ Yes☐ No

If Yes, please provide the docket or disclosure number or any other identifying information below:

**Question 10**

What type of companies do you expect to compete with inventions of this type? Check all that apply.

☒ Manufacturers of enterprise servers☒ Manufacturers of entry servers☒ Manufacturers of workstations☒ Manufacturers of PC's☒ Non-computer manufacturers☐ Developers of operating systems☐ Developers of networking software☐ Developers of application software☐ Integrated solution providers☐ Service providers☒ Other (Please specify below)

Semiconductor Manufacturers for both Logic and DRAM applications.

**Question 11**

If the invention relates to a product or service that is outside the scope of your business unit, please recommend IBM business unit(s), IBM location(s) or individual(s) within IBM that you think would provide a good evaluation of your invention:

**Patent Value Tool (Optional - this may be used by the inventor and attorney to assist with the evaluation.)**  
(The Patent Value tool can be used by the inventor(s) to determine the potential licensing value of your invention.)

These are the answers which were entered into the Patent Value Tool. If you would like to modify these answers and recalculate the PVT score, click on the 'Calculate' button.

**Market**

What is the anticipated annual market size (in dollars) that will be captured by your invention?

Greater than \$5B

Reason(s) for above Answer Low-k films will grow from a W/W \$100M business to over \$1B as logic manufacturers race to introduce low-k films. Future microprocessors (both IBM and others) will all be built with low-k films for increased performance.

**CLAIMS**

Question 1 - How new is the technical field?

Emerging

Reason(s) for above Answer Low-k films have been emerging over the last couple of years. IBM's first low-k product will be CMOS8S2.

**Question 2 - How central is the invention to the product(s) which might be expected to contain the invention?**

Essential

Reason(s) for above Answer PECVD low-k films can be used for single damascene. If a cap layer is used to separate the low-k from the photolithography. However, dual damascene can not be effectively done without a solution to the lithography problem.

**Question 3 - What is the scope of the claim?**

Broad

Reason(s) for above Answer A new oxidizer for a whole range of pecvd low-k films.

#### **PORTFOLIO NEED**

What are the portfolio needs in the area of your invention?

Listed in PPM Needs

Reason(s) for above Answer Low-K is an emerging field and is needed for future processors for the server divisions.

#### **EXPLOITATION & ENFORCEMENT**

**Question 1 - How easily can the use of the invention by a competitor be detected?**

With work

Reason(s) for above Answer detection of the precursors may not be easy after a plasma has dissociated the feed gases.

**Question 2 - How easily can the use of the invention be avoided by a competitor?**

With much work

Reason(s) for above Answer A different precursor might be found that does not adversely affect the film properties.

#### **BUSINESS VALUE**

**Question 1 - What percentage of the companies producing products in the field of this invention might use this invention?**

Broadly cloned

Reason(s) for above Answer A common approach to low-k is to use PECVD for the first generation to extend the life of current pecvd deposition tools, and to avoid the cost of purchasing tracks for spin-on low-k films.

**Question 2 - What is the value of this patent to current or anticipated Alliance Activity between IBM and other companies?**

High value

Reason(s) for above Answer Many companies are looking at PECVD low-k.

**Question 3 - What is the value of this patent to current or anticipated Technology Transfer Activity between IBM and other companies?**

High value

Reason(s) for above Answer For both logic and dram applications, IBM and Infineon would be interested in this. In addition, if DRAM (1GM APOLLO) adopts low-k for improved performance, the technology would probably be transferred to NanYa for DRAM manufacturing.

**Question 4 - Does it result in prestige to IBM?**

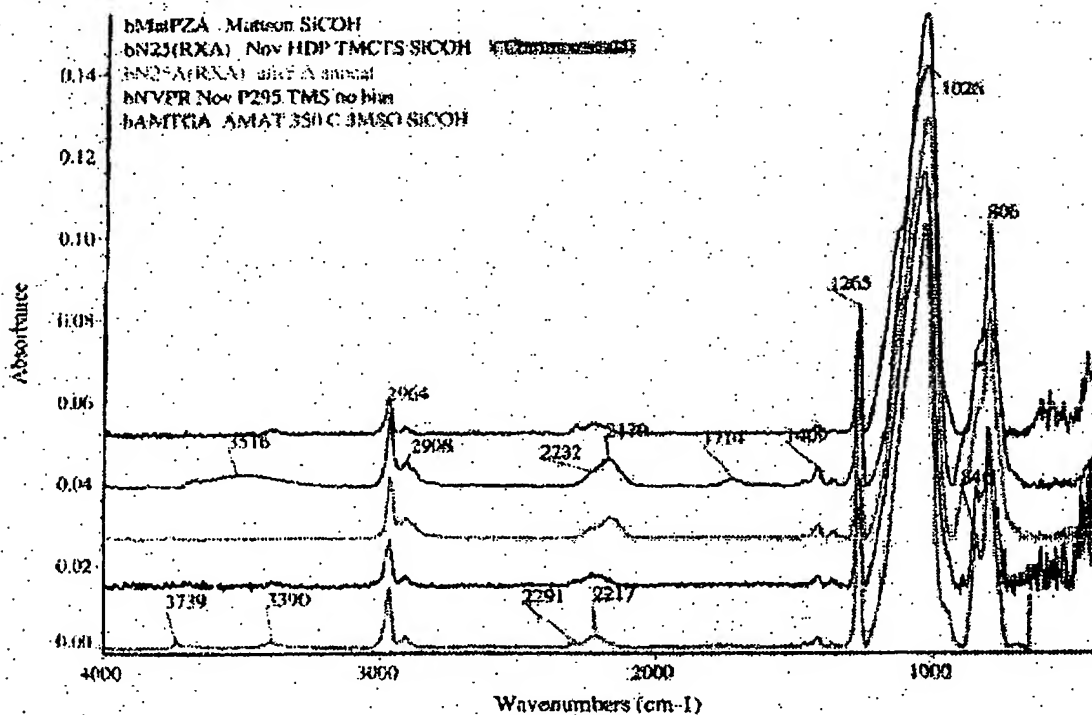
Industry wide

Reason(s) for above Answer An IBM publication with the improved dielectric would spur many to immediately work on this approach.

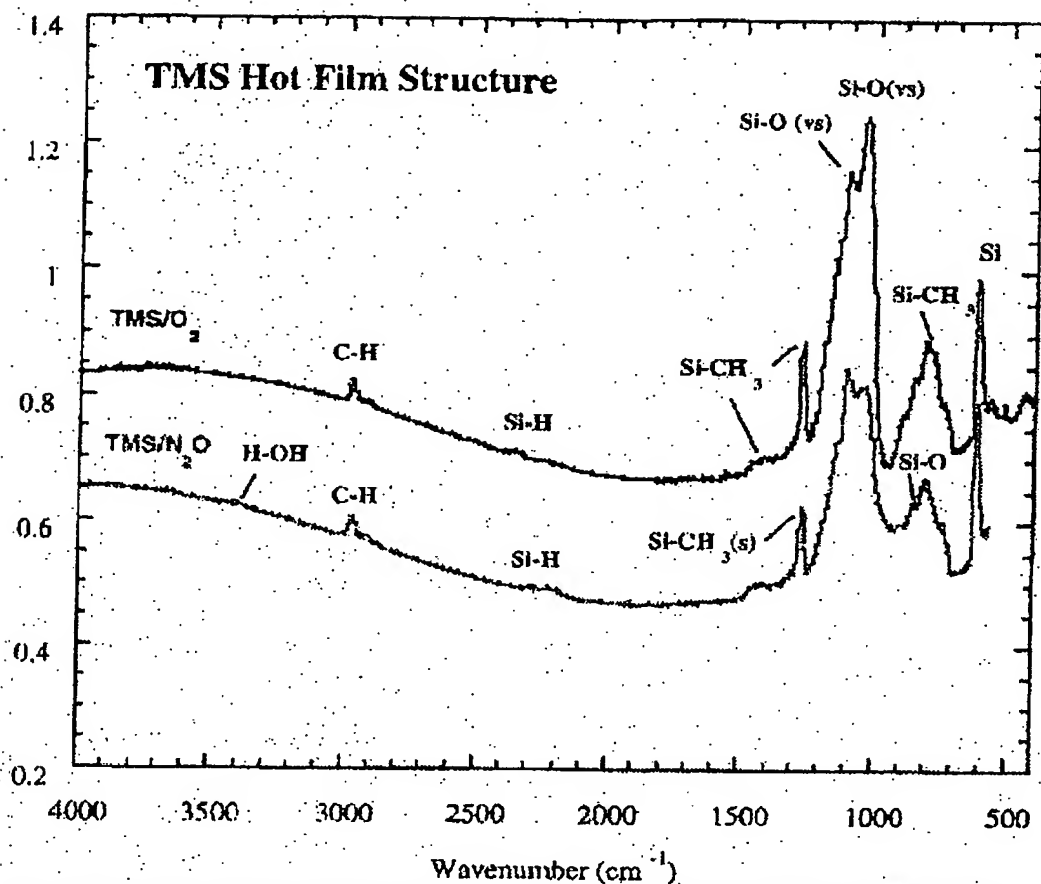


AMAT 3MS/O2/He

bM14PZA Mattson SICOH  
bN2J(RXA) Nov HDP TMCTS SICOH  
bN25A(RXA) and A manual  
bNVER Nov P295 TMS no bin  
bAMTICA AMAT 350C JMSO SICOH



Novellus HDP (OMCTS, not TMCTS) has no N-H bond, but they are not acceptable due to higher k, lower hardness, and water absorption. The rest of films show N-H bond near 3390cm<sup>-1</sup>, which correlate with DUV resist poisoning.



As shown in the FTIR above there is no N-H peak observed in the 3MS / O2 (blue) film.

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SEARCH RECOMMENDED  
**DDA INVENTION DISCLOSURE EVALUATION SUMMARY**

700-0230

DDA INVENTION DISCLOSURE NUMBER	YOR 8-1999-0821
TITLE OF INVENTION (descriptive)	PECVD Low Dielectric Constant
PRIMARY INVENTOR / CONTACT	Dalton, Timothy
TECHNICAL EVALUATOR	Belyansky, Michael

**1) POTENTIAL FOR PROTECTION (Is this invention new, useful, or non-obvious?)**

	YES / NO	COMMENTS
NEW	YES	SPECIFIC APPLICATION (LITHO)
USEFUL		
NON-OBVIOUS		

**2) TECHNICAL EVALUATION (Please cite references and patents where possible)**

What is the most important aspect of this invention?

NEW OXIDATION SPECIES FOR SPECIFIC USE OF LOW-K MATERIALS AT LITHO STEP. (CO and CO<sub>2</sub> SPECIES)

What problem is solved?

USAGE OF NON-NITROGEN CONTAINING LOW-K materials ELIMINATES NITROGEN POISONING OF PHOTORESIST

What existing solutions are known? Please cite references, patents, etc.

PECVD OF SILANE BASED MATERIALS WITH OXYGEN as an OXIDIZING AGENT is KNOWN

6,068,884 - US Patent May 2000. Rose et. al.

What are the TECHNICAL pros and cons over existing solutions?

BENEFITS OF O<sub>2</sub> as an agent are demonstrated

BREAKING OF CO MOLECULE is MORE DIFFICULT (HIGHER POWER MAY BE REQUIRED)

Have you searched for prior art? How was this search performed?

YES

IBM PATENT SEARCH

Which inventors were consulted? Please name others who were consulted.

Timothy Dalton